

CLAIMS

1. A developing apparatus comprising:

a substrate holding unit for holding a substrate in a substantially horizontal attitude, the substrate having an exposed resist thereon;

a developer supply nozzle for delivering a developing solution to the substrate, the developer supply nozzle having therein an ejection port that has a length substantially equal to or larger than a width of an effective area of the substrate;

a diluent supply nozzle for delivering a diluent to the substrate, the diluent supply nozzle having therein an ejection port that has a length substantially equal to or larger than the width of the effective area of the substrate;

a temperature regulating unit for controlling temperature of the developing solution to be supplied from the developer supply nozzle according to a type of the resist on the substrate or a specific geometrical characteristic of a pattern of the resist;

a drive mechanism for moving the developer supply nozzle and the diluent supply nozzle from one end of the substrate to the opposite end of the substrate; and

means for controlling operation of the diluent supply nozzle such that the diluent is supplied to a surface of the substrate at a predetermined timing after the developing solution is supplied to the surface of the substrate from the developer supply nozzle.

2. The developing apparatus according to claim 1, wherein said apparatus includes plural number of said developer supply nozzles, and each of the developer supply nozzles is provided with a temperature regulating unit to control the temperature of a developing solution.

3. The developing apparatus according to claim 2, wherein the developer supply nozzles are integrated together into a single liquid-supplying nozzle unit moved by a common drive mechanism.

4. The developing apparatus according to any one of claims 1 to 3, wherein the developer supply nozzle and the diluent supply nozzle are integrated together into a single liquid-supplying nozzle unit moved by a common drive mechanism.

5. The developing apparatus according to claim 3 or 4, wherein the liquid-supplying nozzle unit is adapted to eject a plurality of developing solutions or diluents through a common ejection port.

6. The developing apparatus according to claim 3 or 4, wherein:

the liquid-supplying nozzle unit has a developer ejection port for ejecting a developing solution and a diluent ejection port for ejecting a diluent; and

the developer ejection port and the diluent ejection port are arranged adjacent each other in a direction of movement of the liquid-supplying nozzle unit.

7. The developing apparatus according to claim 6, wherein:

the developer ejection port is located on a forward side of the liquid-supplying nozzle unit with respect to the direction of movement of the liquid-supplying nozzle unit; and

a suction port is provided between the developer ejection port and the diluent ejection port to suck a developing solution on the surface of the substrate.

8. The developing apparatus according to any one of claims 3 to 7, further comprising means for selecting one of a plurality of prepared developing solutions as a developing solution to be ejected through a developer supply, wherein temperature of the selected developing solution has been adjusted according to the type of the resist on the substrate or the specific geometrical characteristic of the pattern of the resist.

9. The developing apparatus according to claim 8, wherein while said one developing solution is selected, temperature of another developing solution is adjusted.

10. The developing apparatus according to any one of claims 3 to 9, further comprising a control unit for:

storing data showing relationship between types of resists on the substrate to be developed or specific geometrical characteristics of patterns of the resists and developing solution temperatures suitable therefor; and

controlling, based on the data, the temperature regulating unit to adjust the temperature of a developing solution to a value suitable for a resist to be developed.

11. The developing apparatus according to any one of claims 3 to 10, wherein a temperature regulating unit is arranged in a developer supply nozzle to control the temperature of a developing solution.

12. The developing apparatus according to any one of claims 3 to 11, wherein a temperature regulating unit is arranged in the liquid-supplying nozzle.

13. The developing apparatus according to any one of claims 1 to 7, further comprising a concentration control unit for controlling concentration of a developing solution to be supplied through a developer supply nozzle, according to the type of the resist on the substrate to be developed or the specific geometrical characteristic of the pattern of the resist.

14. The developing apparatus according to claim 13, further comprising means for selecting one of a plurality of prepared developing solutions as a developing solution to be ejected through a developer nozzle, wherein the concentration of the selected developing solution has been adjusted according to the

type of the resist on the substrate or the specific geometrical characteristic of the pattern of the resist.

15. The developing apparatus according to claim 14, wherein while said one developing solution is selected, concentration of another developing solution is adjusted.

16. The developing apparatus according to any one of claims 1 to 15, wherein, at any portion of an effective area of the substrate, a diluent is supplied 20 seconds or less after a developing solution is supplied.

17. A developing method comprising the steps of:
applying a developing solution to a surface of an exposed resist film on a substrate by using a nozzle;
adjusting the temperature of the developing solution before the developing solution is applied;
leaving the substrate coated with the developing solution for a predetermined period of time to promote development reaction, thereby dissolving regions of the resist to be removed by the development reaction;
supplying, after the step of leaving the substrate, a diluent for diluting the developing solution to the substrate; and
supplying, after the step of supplying the diluent, a cleaning liquid to the substrate for cleaning;
wherein the temperature of the developing solution is adjusted such that when the substrate is left for the predetermined period of time, the regions of the resist to be removed by the development reaction is dissolved to a required extent.

18. The developing method according to claim 17, wherein each of the step of applying the developing solution and the step of supplying the diluent includes a step of moving a nozzle from one end of the substrate to the opposite end the substrate, the nozzle having therein an ejection port that has a length

substantially equal to or larger than a width of an effective area of the substrate.

19. The developing method according to claim 18, wherein a nozzle movement direction and a nozzle movement speed at the step of supplying the diluent are the same as those at the step of applying the developing solution.

20. The developing method according to any one of claims 17 to 19, wherein the step of applying the developing solution and the step of supplying the diluent use the same nozzle to deliver the developing solution and the diluent, respectively, to the surface of the substrate.

21. The developing method according to any one of claims 17 to 20, wherein:

the developing method is performed by using a developing apparatus including a plurality of developer nozzles; and

said developing method further comprising the step of:

while a developing solution is being applied by using one of the plurality of developer nozzles, adjusting the temperature of a developing solution for another one of the plurality of developer nozzles.

22. The developing method according to claim 21, wherein the plurality of developer nozzles are integrated together into a single liquid-supplying nozzle unit.

23. The developing method according to any one of claims 17 to 20, further comprising the step of:

adjusting temperature and concentration of a developing solution before the developing solution is applied to the substrate.

24. The developing method according to claim 23, wherein:

the developing method is performed by using a developing apparatus including a plurality of developer nozzles; and

said developing method further comprising the step of:

while a developing solution is being applied by using one of the plurality of developer nozzles, adjusting temperature and concentration of a developing solution for another one of the plurality developer nozzles.

25. The developing method according to any one of claims 17 to 24, wherein, at any portion of an effective area of the substrate, a diluent is supplied 20 seconds or less after a developing solution is supplied.